

Title: *The Origin of Solar Eruptions*

Cluster: *Cross-Theme Theory and Data Analysis/SECTP*

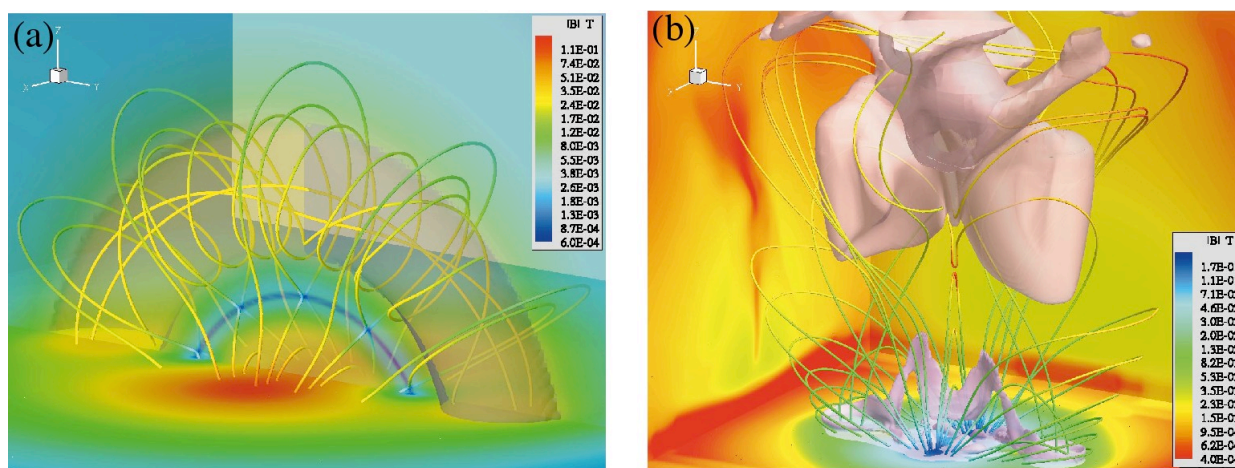
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•Flux Ropes with Feet Anchored in Photosphere can Still Erupt.

The physical mechanisms responsible for coronal mass ejections are still debated within the solar community. Advancing our understanding, the Sun-Earth Connections Theory Group at the University of New Hampshire has developed a comprehensive model for the evolution of a twisted magnetic field configuration, referred to as a "flux rope". Many aspects of this model can be explored analytically, but numerical studies are required to establish its validity for the more complex conditions existing at the Sun. In collaboration with researchers at the University of Michigan, the group has now completed a numerical verification of the analytical model for large-scale solar eruptions. This study employed a 3D analysis of a curved magnetic flux rope that has its ends anchored in the solar surface. According to a previously developed 2D analytical model, the flux rope should erupt upwards when the length of the flux rope, relative to its diameter, exceeds a critical value. The numerical results confirm that the flux rope can indeed erupt if it is sufficiently long. This is a very important result because there has been considerable controversy over the last 15 years as to whether a flux rope with its feet firmly anchored in the photosphere can, in fact, erupt.

Coronal mass ejections are among the most important solar events in space weather. Until the sources and morphologies of these eruptions are understood, we will never have a complete understanding or predictability of the Sun's variability. Realistic theoretical models, that expose the underlying physics of solar eruptions, are required tools for interpreting observations made by solar observatory spacecraft and for the planning of future spacecraft missions.

MODELED ERUPTION OF A FLUX ROPE



Three-Dimensional Flux Rope Configuration Before (A) and (B) 35 Minutes After Eruption. (Solid lines are magnetic field lines, and the false color code visualizes the magnetic field strength. The lower purple shaded surface in (b) is an isosurface of current density, while the upper mauve shaded surface is an isosurface of flow speed corresponding to 200 km/s.)

*Reference: "A Three Dimensional Flux Rope Model for Coronal Mass Ejections Based on a Loss of Equilibrium", Roussev, I. I., T. G. Forbes, T. Gombosi, I. Sokolov, D. L. De Zeeuw, and J. Birn, **Astrophys. J.**, **588**, L45-L48, 2003.*

